

wavelengths of interest, a multilevel optical phase element, and a light modulating electronic display.--

REMARKS

An abstract on a separate sheet was requested by a Notice to File Missing Parts issued by the U.S. Patent and Trademark Office on July 25, 2001. Applicant includes with this Preliminary Amendment the requested abstract on new page 36, which is enclosed herewith. Support for the Abstract of the Invention can be found in the specification at, for example, Claims 1 and 16.

Applicant is amending numbering of Claims 14-27 and 29-34 because the application, as filed, did not include claims numbered 13 or 28. If this amendment is not entered, Applicant will refer to the claims as originally numbered during prosecution. Also, Applicant is amending the claims to correct self-evident errors. No new matter has been added.

If the Examiner believes that a telephone conversation would be helpful in expediting the prosecution of this application, the Examiner is requested to call the undersigned at (781) 861-6240.

Respectfully submitted,

HAMILTON, BROOK, SMITH & REYNOLDS, P.C.

By

N. Scott Pierde

Registration No. 34,900

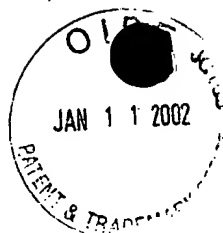
Telephone (781) 861-6240

Facsimile (781) 861-9540

Lexington, Massachusetts 02421-4799

Dated:

9/25/01

MARKED UP VERSION OF AMENDMENTSSpecification Amendments Under 37 C.F.R. § 1.121(b)(1)(iii)

Replace the paragraph at page 2, lines 1 through 3 with the below paragraph marked up by way of underlining to show the change relative to the previous version of the paragraph.

GOVERNMENT SUPPORT

This invention was made with government support under contract number F19628-85-C-0002 awarded by the Air Force. The government has certain rights in the invention.

Claim Amendments Under 37 C.F.R. § 1.121(c)(1)(ii)

1. (Amended) [(Amended)] A method for displaying a color image comprising the steps of:
illuminating a multilevel optical phase element with a light source having a plurality of wavelengths of interest, said multilevel phase element dispersing light from said light source by diffraction and focusing the dispersed light onto an imaging plane; and actuating a light modulating display in the imaging plane having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, within the near field region of said multilevel display element so as to receive said dispersed and focused light from said multilevel optical phase element.
3. (Amended) [(Amended)] The method of claim 1 further comprising providing a light source having a polychromatic spectrum.
4. (Amended) [(Amended)] The method of claim 1 further comprising providing a plurality of subsources each subsource having a different spectral distribution.
5. (Amended) [(Amended)] The method of claim 4 further comprising emitting light from each said subsource with a light emitting diode.
6. (Amended) [(Amended)] The method of claim 4 further comprising providing a laser [as] at each said subsource.

7. (Amended) [(Amended)] The method of claim 1 further comprising providing a multilevel optical phase element that is multilevel in two [othogonal] orthogonal directions.
10. (Amended) [(Amended)] A method for displaying a color image comprising the steps of:
 focusing light, from a light source having a plurality of wavelengths of interest, using a plurality of focusing elements;
 illuminating a multilevel optical phase element with light focused by said plurality of focusing elements, said multilevel phase element dispersing light from said plurality of focusing elements by diffraction and focusing the dispersed light onto an imaging plane; and
 actuating a light modulating display in the imaging plane having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, so as to receive said dispersed light from said multilevel optical phase element.
11. (Amended) [(Amended)] The method of claim 10 further comprising providing said plurality of focusing elements including a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\begin{array}{c} \left| \frac{T^2 Z_s}{3\lambda_{long} Z_s - T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{short} Z_s - 2 T^2} \right| \\ \\ \frac{2 T^2 Z_s}{3\lambda_{long} Z_s - 2 T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{short} Z_s - 2 T^2} \end{array} \right]$$

$$\frac{2 T^2 Z_s}{3\lambda_{long} Z_s - 2 T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{short} Z_s - 2 T^2}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

12. (Amended) The method of claim 11 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\begin{array}{l} \frac{T^2 Z_s}{3\lambda_{\text{long}} Z_s - T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{\text{short}} Z_s - 2 T^2} \\ \frac{2 T^2 Z_s}{3\lambda_{\text{long}} Z_s - 2 T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{\text{short}} Z_s - 2 T^2} \end{array} \right]$$

$$\frac{2 T^2 Z_s}{3\lambda_{\text{long}} Z_s - 2 T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{\text{short}} Z_s - 2 T^2}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

- [14]13. (Amended) The method of claim 11 wherein said multilevel optical phase element is constructed such that a magnification produced by said plurality of lenslets produces [an] a dispersion element of a size substantially equal to the dimensions of each pixel element in said display.

- [15]14. (Amended) The method of claim [14] 13 wherein said magnification (M) is given by the equation:

$$M = 1 + \frac{Z}{Z_s}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets and Z is the distance between said multilevel optical phase element and said display.

- [16]15. (Amended) [(Amended)] A system for displaying a color image comprising:
 a light source emitting a plurality of wavelengths of interest;
 a multilevel optical phase element positioned to receive light from said light source, said multilevel phase element dispersing light from said light source by diffraction and focusing the dispersed light onto an imaging phase; and
 a light modulating electronic display positioned in the imaging plane and having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, positioned within the near field region of said multilevel optical phase so as to receive said dispersed light from said multilevel phase element.

- [17]16. (Amended) The system of claim [16] 15 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{T^2}{3\lambda_{Long}} < Z < \frac{2T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, λ_{Long} is the longest wavelength of said plurality of wavelengths of interest and λ_{Short} is the shortest wavelength of said plurality of wavelengths of interest.

- [18]17. (Amended) The system of claim [17] 16 wherein said display is positioned at a distance from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{2T^2}{3\lambda_{Long}} < Z < \frac{2T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, λ_{Long} is the longest wavelength of said plurality of wavelengths of interest and λ_{Short} is the shortest wavelength of said plurality of wavelengths of interest.

- [19]18. (Amended) The system of claim [17] 16 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{T^2}{3\lambda_{Long}} < Z < \frac{T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, λ_{Long} is the longest wavelength of said plurality of wavelengths of interest and λ_{Short} is the shortest wavelength of said plurality of wavelengths of interest.

- [20]19. (Amended) [(Amended)] The system of claim [17] 16 wherein said light source has a polychromatic spectrum.

- [21]20. (Amended) The system of claim [16] 15 wherein said light source comprises a plurality of subsources each subsource having a different spectral distribution.

- [22]21. (Amended) The system of claim [21] 20 wherein each said subsource is a light emitting diode.

- [23]22. (Amended) The system of claim [21] 20 wherein each said subsource is a laser.

- [24]23. (Amended) The system of claim [16] 15 wherein said multilevel optical phase element is multilevel in two [othagonal] orthogonal directions.

- [25]24. (Amended) [(Amended)] A system for displaying a color image comprising[;]; a light source having a plurality of wavelengths of interest; a plurality of focusing elements positioned to focus light from said light source; a multilevel optical phase element positioned to receive light [focused] focused by said plurality of focusing elements, said multilevel phase element dispersing light from said plurality of focusing elements by diffraction and focusing the dispersed light onto an imaging plane; and

a light modulating electronic display positioned in the imaging plane and having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, positioned so as to receive said dispersed light from said multilevel optical phase element.

- [26]25. (Amended) [(Amended)] The system of claim [25] 24 wherein said plurality of focusing elements comprises a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\begin{array}{l} \frac{T^2 Z_s}{3\lambda_{long} Z_s - T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2} \\ \frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2} \end{array} \right]$$

$$\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets, λ_{long} is the largest wavelength of said plurality of wavelengths of interest[;] and λ_{short} is the shortest wavelength of said plurality of wavelengths of interest.

- [27]26. (Amended) The system of claim [26] 25 wherein said plurality of focusing elements comprises a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2} \right]$$

$$\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets, λ_{long} is the largest wavelength of said plurality of wavelengths of interest[;] and λ_{short} is the shortest wavelength of said plurality of wavelengths of interest.

- [29]27. (Amended) The system of claim [25] 24 wherein said multilevel optical phase element is constructed such that a magnification produced by said plurality of lenslets produces [an] a dispersion element substantially equal to the dimensions of each pixel element in said display.
- [30]28. (Amended) The system of claim [29] 27 wherein said magnification (M) is given by the equation:

$$M = 1 + \frac{Z}{Z_s}$$

wherein T is the periodicity of said multilevel optical phase element, Z is the distance between said multilevel optical phase element and said display and Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

- [31]29. (Amended) The system of claim [25] 24 wherein said multilevel optical phase element is multilevel in two [othagonal] orthogonal directions.
- [32]30. (Amended) The system of claim [25] 24 wherein said light source comprises a plurality of subsources each subsource having a different spectral distribution.
- [33]31. (Amended) The system of claim [32] 30 wherein each said subsource is a light emitting diode.

[34]32. (Amended) The system of claim [32] 30 wherein each said subsource is a laser.

09/895,865

MARKED UP VERSION OF AMENDMENTSSpecification Amendments Under 37 C.F.R. § 1.121(b)(1)(iii)

Replace the paragraph at page 2, lines 1 through 3 with the below paragraph marked up by way of underlining to show the change relative to the previous version of the paragraph.

GOVERNMENT SUPPORT

This invention was made with government support under contract number F19628-85-C-0002 awarded by the Air Force. The government has certain rights in the invention.

Claim Amendments Under 37 C.F.R. § 1.121(c)(1)(ii)

1. (Amended) [(Amended)] A method for displaying a color image comprising the steps of:
illuminating a multilevel optical phase element with a light source having a plurality of wavelengths of interest, said multilevel phase element dispersing light from said light source by diffraction and focusing the dispersed light onto an imaging plane; and actuating a light modulating display in the imaging plane having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, within the near field region of said multilevel display element so as to receive said dispersed and focused light from said multilevel optical phase element.
3. (Amended) [(Amended)] The method of claim 1 further comprising providing a light source having a polychromatic spectrum.
4. (Amended) [(Amended)] The method of claim 1 further comprising providing a plurality of subsources each subsource having a different spectral distribution.
5. (Amended) [(Amended)] The method of claim 4 further comprising emitting light from each said subsource with a light emitting diode.
6. (Amended) [(Amended)] The method of claim 4 further comprising providing a laser [as] at each said subsource.

7. (Amended) [(Amended)] The method of claim 1 further comprising providing a multilevel optical phase element that is multilevel in two [othogonal] orthogonal directions.
10. (Amended) [(Amended)] A method for displaying a color image comprising the steps of:
 focusing light, from a light source having a plurality of wavelengths of interest, using a plurality of focusing elements;
 illuminating a multilevel optical phase element with light focused by said plurality of focusing elements, said multilevel phase element dispersing light from said plurality of focusing elements by diffraction and focusing the dispersed light onto an imaging plane; and
 actuating a light modulating display in the imaging plane having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, so as to receive said dispersed light from said multilevel optical phase element.
11. (Amended) [(Amended)] The method of claim 10 further comprising providing said plurality of focusing elements including a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\begin{array}{c} \left| \frac{T^2 Z_s}{3\lambda_{long} Z_s - T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{short} Z_s - 2 T^2} \right| \\ \\ \frac{2 T^2 Z_s}{3\lambda_{long} Z_s - 2 T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{short} Z_s - 2 T^2} \\ \\ \hline \end{array} \right]$$

$$\frac{2 T^2 Z_s}{3\lambda_{long} Z_s - 2 T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{short} Z_s - 2 T^2}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

12. (Amended) The method of claim 11 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\begin{array}{l} \frac{T^2 Z_s}{3\lambda_{long} Z_s - T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{short} Z_s - 2 T^2} \\ \\ \frac{2 T^2 Z_s}{3\lambda_{long} Z_s - 2 T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{short} Z_s - 2 T^2} \end{array} \right]$$

$$\frac{2 T^2 Z_s}{3\lambda_{long} Z_s - 2 T^2} < Z < \frac{2 T^2 Z_s}{3\lambda_{short} Z_s - 2 T^2}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

- [14]13. (Amended) The method of claim 11 wherein said multilevel optical phase element is constructed such that a magnification produced by said plurality of lenslets produces [an] a dispersion element of a size substantially equal to the dimensions of each pixel element in said display.

- [15]14. (Amended) The method of claim [14] 13 wherein said magnification (M) is given by the equation:

$$M = 1 + \frac{Z}{Z_s}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets and Z is the distance between said multilevel optical phase element and said display.

- [16]15. (Amended) [(Amended)] A system for displaying a color image comprising:
 a light source emitting a plurality of wavelengths of interest;
 a multilevel optical phase element positioned to receive light from said light source, said multilevel phase element dispersing light from said light source by diffraction and focusing the dispersed light onto an imaging phase; and
 a light modulating electronic display positioned in the imaging plane and having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, positioned within the near field region of said multilevel optical phase so as to receive said dispersed light from said multilevel phase element.

- [17]16. (Amended) The system of claim [16] 15 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{T^2}{3\lambda_{Long}} < Z < \frac{2T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, λ_{Long} is the longest wavelength of said plurality of wavelengths of interest and λ_{Short} is the shortest wavelength of said plurality of wavelengths of interest.

- [18]17. (Amended) The system of claim [17] 16 wherein said display is positioned at a distance from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{2T^2}{3\lambda_{Long}} < Z < \frac{2T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, λ_{Long} is the longest wavelength of said plurality of wavelengths of interest and λ_{Short} is the shortest wavelength of said plurality of wavelengths of interest.

- [19]18. (Amended) The system of claim [17] 16 wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\frac{T^2}{3\lambda_{Long}} < Z < \frac{T^2}{3\lambda_{Short}}$$

wherein T is the periodicity of said multilevel optical phase element, λ_{Long} is the longest wavelength of said plurality of wavelengths of interest and λ_{Short} is the shortest wavelength of said plurality of wavelengths of interest.

- [20]19. (Amended) [(Amended)] The system of claim [17] 16 wherein said light source has a polychromatic spectrum.
- [21]20. (Amended) The system of claim [16] 15 wherein said light source comprises a plurality of subsources each subsource having a different spectral distribution.
- [22]21. (Amended) The system of claim [21] 20 wherein each said subsource is a light emitting diode.
- [23]22. (Amended) The system of claim [21] 20 wherein each said subsource is a laser.
- [24]23. (Amended) The system of claim [16] 15 wherein said multilevel optical phase element is multilevel in two [othagonal] orthogonal directions.
- [25]24. (Amended) [(Amended)] A system for displaying a color image comprising[;]:
a light source having a plurality of wavelengths of interest;
a plurality of focusing elements positioned to focus light from said light source;
a multilevel optical phase element positioned to receive light [focused] focused by said plurality of focusing elements, said multilevel phase element dispersing light from said plurality of focusing elements by diffraction and focusing the dispersed light onto an imaging plane; and

a light modulating electronic display positioned in the imaging plane and having a plurality of pixel elements, each said pixel element assigned to transmit a predetermined spectral region, positioned so as to receive said dispersed light from said multilevel optical phase element.

- [26]25. (Amended) [(Amended)] The system of claim [25] 24 wherein said plurality of focusing elements comprises a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\begin{array}{c} \frac{T^2 Z_s}{3\lambda_{long} Z_s - T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2} \\ \\ \frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2} \end{array} \right]$$

$$\underline{\underline{\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}}}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets, λ_{long} is the largest wavelength of said plurality of wavelengths of interest[;] and λ_{short} is the shortest wavelength of said plurality of wavelengths of interest.

- [27]26. (Amended) The system of claim [26] 25 wherein said plurality of focusing elements comprises a plurality of lenslets and wherein said display is positioned at a distance Z from said multilevel optical phase element, wherein Z is determined by the relationship:

$$\left[\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2} \right]$$

$$\frac{2T^2 Z_s}{3\lambda_{long} Z_s - 2T^2} < Z < \frac{2T^2 Z_s}{3\lambda_{short} Z_s - 2T^2}$$

wherein T is the periodicity of said multilevel optical phase element, Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets, λ_{long} is the largest wavelength of said plurality of wavelengths of interest[;] and λ_{short} is the shortest wavelength of said plurality of wavelengths of interest.

[29]27. (Amended) The system of claim [25] 24 wherein said multilevel optical phase element is constructed such that a magnification produced by said plurality of lenslets produces [an] a dispersion element substantially equal to the dimensions of each pixel element in said display.

[30]28. (Amended) The system of claim [29] 27 wherein said magnification (M) is given by the equation:

$$M = 1 + \frac{Z}{Z_s}$$

wherein T is the periodicity of said multilevel optical phase element, Z is the distance between said multilevel optical phase element and said display and Z_s is equal to the distance between said multilevel optical phase element and said lenslets minus the focal length of said lenslets.

[31]29. (Amended) The system of claim [25] 24 wherein said multilevel optical phase element is multilevel in two [othagonal] orthogonal directions.

[32]30. (Amended) The system of claim [25] 24 wherein said light source comprises a plurality of subsources each subsource having a different spectral distribution.

[33]31. (Amended) The system of claim [32] 30 wherein each said subsource is a light emitting diode.

[34]32. (Amended) The system of claim [32] 30 wherein each said subsource is a laser.